Automated Monitoring for safety at level crossings

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OBJECTIVES OF THE SAFER–LC PROJECT

♦ Identification of principle factors of accident at LC.

♦ Real time detection, recognition and evaluation of potentially dangerous situations at level crossing

♦ Sharing alert messages by a communication system

♦ Research and experimentation of technical solutions.
INITIAL IDEA

Railway traffic control center
Alert information to road/railway operators

Road traffic control center

LC dedicated detection and communication equipment

Train drivers alert messages delivered as a function of the distance to the LC via ERTMS (MMI and train odometry - GNSS)

Road vehicles alert message delivered as a function of the distance to the LC, using GNSS information
GLOBAL SYNOPTIC OF SMART DETECTION SYSTEM
SMART DETECTION SYSTEM CHAIN

Data acquisition → Object detection → Object tracking → event detection → events

Video compression

Object classification

Videos for the control center

Event 1: obstacle at LC
Event 2: traffic jam
Event 3: atypical behavior
Event 4: pedestrian at LC
ALGORITHMS DEVELOPED

-Detection
-Tracking
-- semantic classification
-Scene interpretation
-Evaluation of the dangerousness of the situation

-Classical methods (GMM, SVM, Codebook, etc...)
-- Deep learning methods (CNN.....)
Tests Aachen

Equipment installed inside the garage

Level crossing

Test 1 (Aachen) (results)

Event sent to the

RSU interface

Example of detection of cyclist
Datasets

Four different datasets were used: the global datasets recorded at Cerema (2 sessions) and the two datasets recorded in Aachen Germany. This represents more than 4 hours of events to detect: obstacles, pedestrians presence, atypical behaviour, traffic jam.

- 41 videos including 1038 events whatever the scenario.

We have kept
- 24 videos coming from Cerema datasets (523 events),
  - 8 videos from the first session of Aachen (118 events)
  - and 9 videos of the Aachen second session (397 events).
Performance indicators for the SDS

\[ \text{Perf\_Detect} = \frac{\text{number of events detected by the SDS}}{\text{number of the events correctly detected by the SDS + number of events non detected}} \]

The indicator \textit{Perf\_Detect\_Weather} is used to calculate the ability of the SDS to detect events according to the weather conditions.

<table>
<thead>
<tr>
<th>Weather</th>
<th>Perf_Detect_Weather</th>
</tr>
</thead>
<tbody>
<tr>
<td>High sun with shadows created by objects, wind</td>
<td>80,17%</td>
</tr>
<tr>
<td>Sun and shadow on the LC</td>
<td>100%</td>
</tr>
<tr>
<td>Cloudy and low illumination</td>
<td>73,54%</td>
</tr>
<tr>
<td>Snow and low illumination</td>
<td>93,65%</td>
</tr>
<tr>
<td>Cloudy with low average illumination with small rain</td>
<td>87,78%</td>
</tr>
<tr>
<td>Snow with very low illumination</td>
<td>100%</td>
</tr>
<tr>
<td>Cloudy with higher illumination</td>
<td>88,89%</td>
</tr>
</tbody>
</table>

Global datasets: 83.7%

Cerema datasets: 78.83%

Aachen datasets: 88%
We recall that our scenarios are including cars, pedestrians, bicycles, etc….. So in this case it could be useful to calculate a second indicator that we call \( \text{Perf\_Detect\_Recog} \). It is calculated like that

\[
\text{Perf\_Detect\_Recog} = \frac{\text{number of events recognized by the SDS}}{\text{number of the events correctly recognized by the SDS} + \text{number of events not correctly recognized}}
\]

<table>
<thead>
<tr>
<th>Weather</th>
<th>Perf_Detect_Recog Weather</th>
</tr>
</thead>
<tbody>
<tr>
<td>High sun with shadows created by objects, wind</td>
<td>68,56%</td>
</tr>
<tr>
<td>Sun and shadow on the LC</td>
<td>100%</td>
</tr>
<tr>
<td>Cloudy and low illumination</td>
<td>72%</td>
</tr>
<tr>
<td>Snow and low illumination</td>
<td>77,54%</td>
</tr>
<tr>
<td>Cloudy with low average illumination with small rain</td>
<td>70,21%</td>
</tr>
<tr>
<td>Snow with very low illumination</td>
<td>38,82%</td>
</tr>
<tr>
<td>Cloudy with higher illumination</td>
<td>100%</td>
</tr>
</tbody>
</table>
PERSPECTIVES

- The dangerous occurrence detection system at the level crossing is coupled with a communication system so that the alert information are sent to motorists, to the train, to the control center. That’s what was carried out within the framework of the European project Safer–LC

- More intensive evaluation on real data coming from LC

Thank you

Safer-lc.eu
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Smart and Sustainable Mobility for all.

Thank you!